Small Wind Turbine Testing and Applications Development

by David Corbus 12/99

Introduction

Small wind turbines offer a promising alternative for many remote electrical uses where there is a good wind resource. The National Wind Technology Center (NWTC), part of the National Renewable Energy Laboratory (NREL), helps to further the role that small wind turbines can play in supplying remote power needs by testing small turbines. The goal of this work is to characterize small wind turbines and wind-hybrid systems in order to expand the international market for these systems.

Data Acquisition Development

Reliable technical monitoring of hybrid power systems is crucial for evaluating their performance and cost and troubleshooting problems. Valid data sets can be fed into analytical models for a long-term simulation of the system's performance and development of recommendations to improve a system's operational characteristics. Typical monitoring systems for wind-diesel hybrid sites include the following major components: datalogger; wind speed/direction, solar radiation (depending on site) and temperature sensors; power measuring equipment (voltage, current, and power transducers); and fuel consumption gages (optional). The number of sensors and measurement frequency depend on the system's complexity and monitoring objectives.

The NWTC has gathered a vast amount of experience in data acquisition system (DAS) development, installation, and testing for remote wind-diesel hybrid sites in various countries, including Mexico, Chile, Brazil, and Russia. These systems have proved their reliability and durability over long periods of operation and have provided a number of important data sets. However, a recurrent problem with these systems is that the retrieval of stored data is not reliable.

To address this, NREL is working with the Southwest Technology Development Institute at New Mexico State University in Las Cruces, New Mexico, to develop three advanced DAS units to be used as the model on which all other data acquisition systems installed on remote power systems by the Laboratory will be designed. These monitoring stations are equipped with remote communication capabilities through the use of satellites or cellular telephones. One of these prototype systems will be installed at the NWTC, while two other similar systems will be used on power systems in southern Chile. Technicians at NREL have also constructed an additional DAS that has been installed in San Juanico, Mexico, to monitor a large power system at that location. All of these state-of-the-art DAS units have incorporated the "lessons learned" from previous installations.

Small Turbine Testing

The role of the applications group in small turbine testing is to develop a database of wind turbines, which includes performance, robustness, and functionality data. This information is very useful as feedback to the industry; it is also important in evaluating turbines for international pilot projects.

Wind turbine power and the wind resource are measured during the performance testing. Although the turbine performance characterization process does not, nor is it meant to, produce power curves in accordance with international certification standards, it does serve as a useful tool for long-term monitoring by providing a quantitative means of tracking turbine performance over time. We have found that careful examination of the collected performance data can identify potential improvements in the turbine design.

Although a decrease in wind turbine production over time provides a clear indication of what portions of the power generation systems need improvements or optimization, the more frequent type of failure observed in the field is that which results in complete loss of power generation capability. The wind turbine and its control

system's characteristics that lead to this type of failure are best revealed by long-term exposure to a variety of conditions, including severe wind conditions.

The wind regime at the NWTC includes periods of sustained high winds, along with moments of hurricane-force winds. As a result, the NWTC's test bed is very effective at exposing turbine and controller weaknesses, which may manifest themselves only after extended periods of field deployment. Each wind turbine tested at the NWTC is operated for at least 1,500 hours above cut-in wind speed. Periodically throughout the test, the wind turbine and controller are inspected both visually for wear and for electrical performance characteristics. Information gleaned from these tests regarding possible improvements to the wind turbines and controllers is provided to the manufacturers. The resulting modifications made by the manufacturers lead to more reliable wind turbine systems and more favorable field deployments.

Future Work

Future work for the applications development and testing team will include continued testing of commercial or near-commercial products for the remote electrification market. Specifically, controllers for wind-electric water-pumping systems will be tested. Adding to the health post replication will be a rural productivity zone replication that will demonstrate some of the common productive use applications (i.e., income generating) found in remote communities that are powered from renewable energy systems. Small wind hybrid systems and data acquisition systems will continue to be tested. Finally, the prototype peak power tracker under development by Ascension Technology will be tested at the NWTC.

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